Prolonged local carbon sequestration contributed to global carbon cycle recovery following the Toarcian Oceanic Anoxic Event

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Abstract

The Toarcian Oceanic Anoxic Event (T-OAE, Early Jurassic, ∼183 Ma) was marked by one of the largest carbon-cycle perturbations of the Mesozoic Era, thought to have been linked to carbon degassing associated with Karoo and Ferrar large igneous province (LIP) volcanism. The T-OAE is characterized by an up to ∼7‰ negative carbon-isotope excursion (CIE) in marine and terrestrial organic matter and calcite, superimposed on a longer-lasting positive CIE spanning the entire Lower Toarcian. Climatic disturbance at this time led to the geographically widespread development of marine (and lacustrine) dys- and anoxia and euxinia, and an associated increase in global average organic-carbon burial rates. Consequently, marginal marine basins in both hemispheres (as well as major lacustrine basins) commonly show significant sedimentary total organic carbon (TOC) enrichments over the interval of the T-OAE negative CIE. However, some marine basins experienced sustained organic-carbon sequestration, well past the main phase of the T-OAE. Here, we present new high-resolution stratigraphic and XRF-scanning data from cores spanning the Posidonienschiefer (Posidonia Shale) in the Lower Saxony Basin (NW Germany). Astrochronological analyses of the data show that carbon sequestration in this basin persisted for > 2 million years. Utilizing obtained carbon-burial fluxes and carbon-cycle mass balance calculations we show that prolonged local (basin-wide) carbon burial was instrumental for the rapid removal of significant amounts of carbon from the global ocean–atmosphere system, thus significantly speeding up Toarcian carbon-cycle (and climatic) recovery.

Keywords: Toarcian oceanic anoxic event, astrochronology, Posidonia Shale, Lower Saxony Basin

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